

NREL Beam (3D Beam for ADAMS interface)

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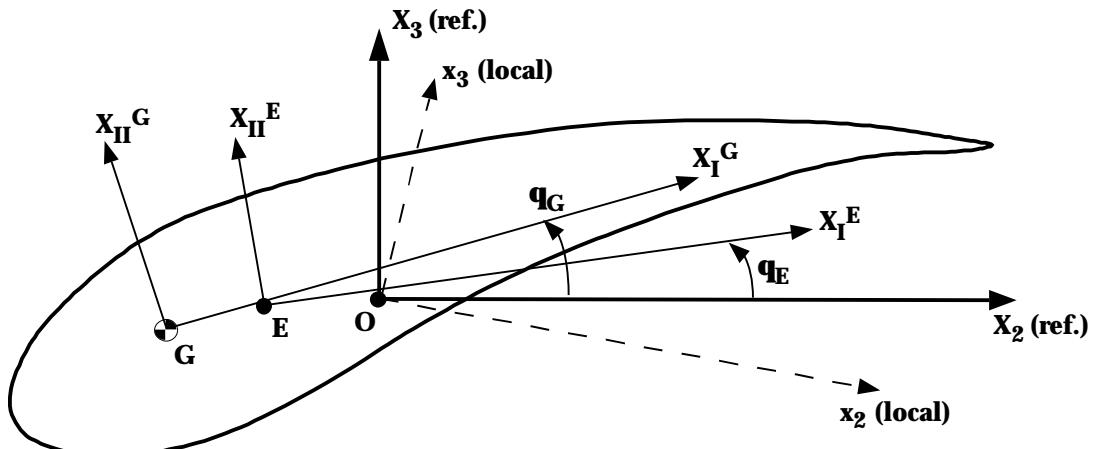
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1. Introduction

The purpose of the Adams interface version of **3D Beam** is to generate the input information of ADAMS program for dynamic analysis. This version also enables us to generate two well-known airfoil shapes. Either for these or for an user-defined cross sections, **3D Beam** calculates the following :

- 1) Area of cross section
- 2) Location of center of elastic axes ($\mathbf{X}_{2c}^E, \mathbf{X}_{3c}^E$)
- 3) Elastic principal moment of inertia at elastic center (I_I^E, I_{II}^E)
- 4) Orientation of elastic principal axes with respect to reference axes (\mathbf{q}_E)
- 5) Mass of each element
- 6) Location of center of mass of cross section ($\mathbf{X}_{2c}^G, \mathbf{X}_{3c}^G$)
- 7) Mass principal moment of inertia at mass center (I_I^G, I_{II}^G)
- 8) Orientation of mass principal axes with respect to reference axes (\mathbf{q}_G)
- 9) Stiffness matrix of each element of ADAMS



2. System requirements

- 1) PC/Mac machine
- 2) Microsoft Excel 5.0 or later

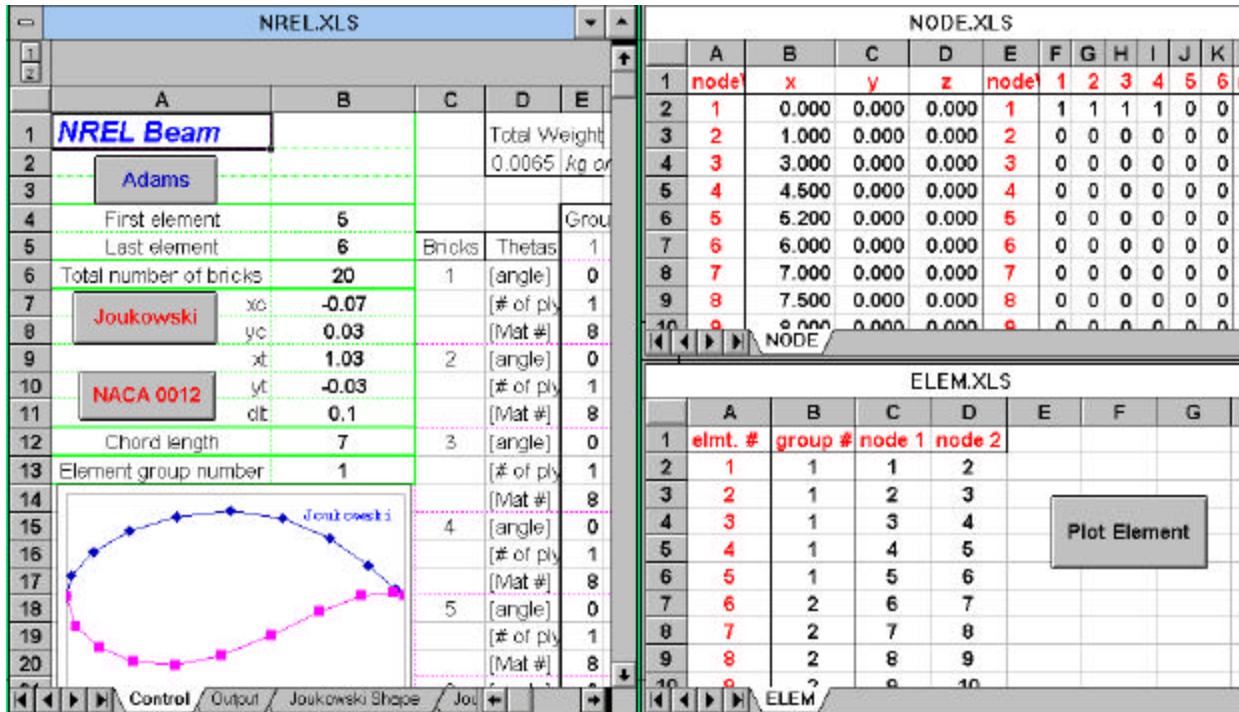
3. Input guide

3.0. Before getting started

- 1) Read **3D Beam** manual to understand terminology used in **this 3D Beam ADAMS interface** manual.

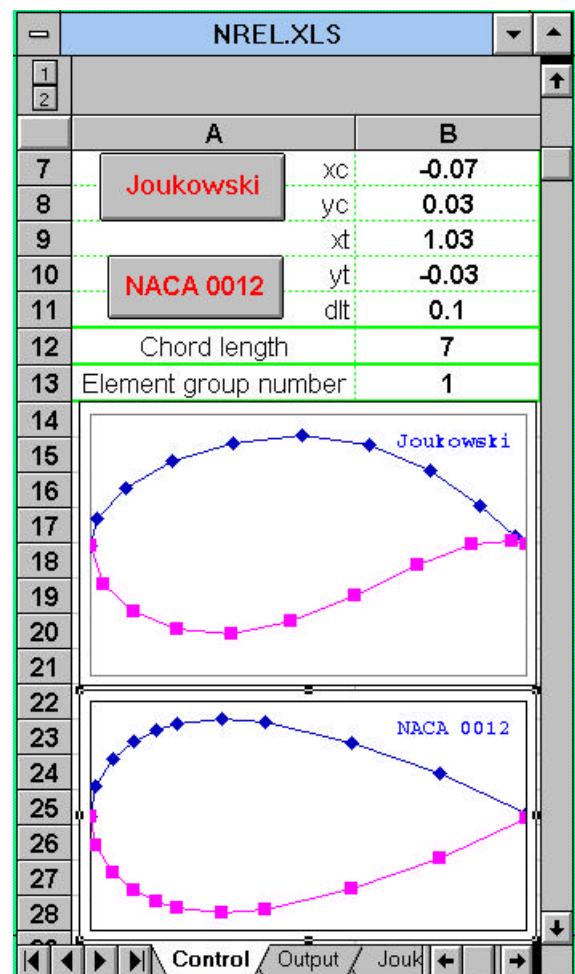
3.1. Getting started

- 1) Open **NREOPEN.XLW** to open 3 files -**NREL.XLS**, **NODE.XLS**, **ELEM.XLS** and several hidden files.
- 2) If cross sections are either Joukowski or NACA 0012 airfoils, go to next step 3.2.
If cross sections are user defined shapes, go to step 3.3.



3.2. Generating airfoil shape

- 1) Select **Control** sheet of **NREL.XLS** file.
- 2) Input necessary parameters for generating airfoil shape :
 - a) For Joukowski airfoil, input X_c , Y_c , X_t , Y_t , Δt , chord length.
 - b) For NACA 0012, input chord length.
- 3) Check the generated airfoil shape by choosing either **Joukowski Shape** sheet or **NACA 0012 Shape** sheet. You can check numeric values of coordinates by choosing either **Joukowski** sheet or **NACA 0012** sheet.
- 4) Input an element group number of cross section. (The element group is a group of elements that have the same geometry and material among all elements. For example, if the beam is uniform along beam direction, the number of element group is one.)
- 5) Click the red button ('Joukowski' or 'NACA 0012') to copy the generated coordinates of airfoil shape into the element group number of cross section input in previous step 3.2.4).
- 6) Go to step 3.4.



3.3. Inputting user-defined cross section shape

- 1) Select **Control** sheet of **NREL.XLS** file.
- 2) Input the discretized coordinates of cross section shape into the cells for reference coordinates (X_2-X_3) of a desired element group number.

	O	P	Q
5	x_2	x_3	
6	0.00000	0.00000	1
7	0.08750	0.13258	
8			
9	0.08750	0.13258	2
10	0.35000	0.24885	
11			
12	0.35000	0.24885	3
13	0.70000	0.32781	
14			
15	0.70000	0.32781	4
16	1.05000	0.37415	

3.4. Inputting material data

- 1) Go to the material input section of desired element group.
- 2) Input angles of fiber, number of plies in laminate and material number for each brick of cross section of the element group.
- 3) Repeat the previous steps (3.2 - 3.4) to generate the elements group as many as the beam has. Do not forget the number of bricks of all element groups must be same.

NREL.XLS												
	C	D	E	F	G	H	I	J	K	L	M	N
1		Total Weight										
2		0.0085	kg or lbf									
3												
4												
5	Bricks	Group #	1		weight/length	###						
6	1	[angle]	0	90	0	90	90	0	90	0	0	0
7		[# of ply]	1	1	1	1	1	1	1	1	0	0
8		[Mat #]	8	8	8	8	8	8	8	8	0	0
9	2	[angle]	0	90	0	90	90	0	90	0	0	0
10		[# of ply]	1	1	1	1	1	1	1	1	0	0
11		[Mat #]	8	8	8	8	8	8	8	8	0	0
12	3	[angle]	0	90	0	90	90	0	90	0	0	0
13		[# of ply]	1	1	1	1	1	1	1	1	0	0
14		[Mat #]	8	8	8	8	8	8	8	8	0	0
15	4	[angle]	0	90	0	90	90	0	90	0	0	0
16		[# of ply]	1	1	1	1	1	1	1	1	0	0
17		[Mat #]	8	8	8	8	8	8	8	8	0	0
18	5	[angle]	0	90	0	90	90	0	90	0	0	0
19		[# of ply]	1	1	1	1	1	1	1	1	0	0
20		[Mat #]	8	8	8	8	8	8	8	8	0	0

3.5. Inputting node and element data

- 1) Select **NODE** sheet of **NODE.XLS** file.
- 2) Input coordinates of nodal points along beam longitudinal direction.
- 3) Ignore boundary condition inputs for the purpose of ADAMS interface.
- 4) Select **ELEM** sheet of **ELEM.XLS** file.
- 5) Input element group numbers and nodal connectivity of all elements discretized by the nodal points.

NODE.XLS				
	A	B	C	D
1	node#	x	y	z
2	1	0.000	0.000	0.000
3	2	1.000	0.000	0.000
4	3	3.000	0.000	0.000
5	4	4.500	0.000	0.000
6	5	5.200	0.000	0.000
7	6	6.000	0.000	0.000
8	7	7.000	0.000	0.000
9	8	7.500	0.000	0.000
10	9	8.000	0.000	0.000
11	10	9.000	0.000	0.000
12	11	10.000	0.000	0.000

ELEM.XLS				
	A	B	C	D
1	elmt. #	group #	node 1	node 2
2	1		1	2
3	2		1	3
4	3		1	4
5	4		1	5
6	5		1	6
7	6		2	7
8	7		2	8
9	8		2	9
10	9		2	10
11	10		2	11

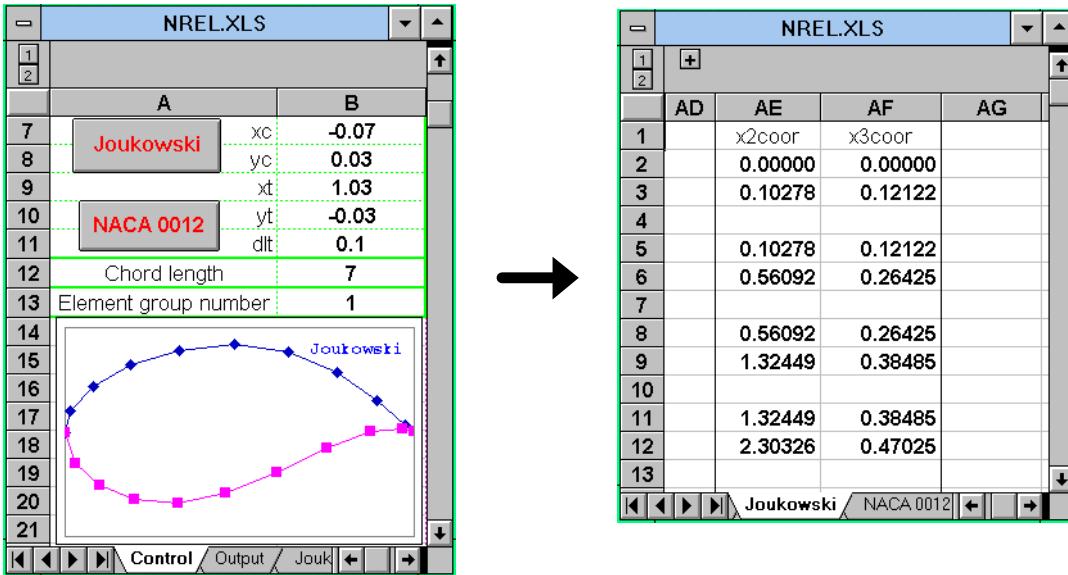
3.6. Generating ADAMS interface data

- 1) Select **Control** sheet of **NREL.XLS** file again.
- 2) Input number of bricks. Then input the first and last element number for ADAMS interface output.
- 3) Click the blue button ('ADAMS') to generate ADAMS interface data.
- 4) Select **Output** sheet of **NREL.XLS** file to check the output.

4. Example

1) Step 3.2 : Make a Joukowsky airfoil for element group #2 with following parameters :

$X_c = -0.07$, $Y_c = 0.03$, $X_t = 1.03$, $Y_t = -0.03$, $\Delta t = 0.1$, chord length = 7



Exercise) Make a NACA 0012 airfoil for element group #1 with the same parameters.

2) Step 3.4 : Input material data for element group #1 with following parameters :

- Material number : 8 (T300/N5208)
- Layup : $[0/90]_{2S}$
- Angle between local axes and reference axes : 15°

NREL.XLS														
C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
3														
4														
5	Bricks	Thetas	Group #	1	weight/length	##						angle_2	15.000	
6	1	[angle]	1	0	90	0	90	90	0	90	0	0	0	0.00000
7		[# of ply]	2	1	1	1	1	1	1	1	1	0	0	0.08750
8		[Mat #]	3	8	8	8	8	8	8	8	8	0	0	0.13258
9	2	[angle]	4	0	90	0	90	90	0	90	0	0	0	0.08750
10		[# of ply]	5	1	1	1	1	1	1	1	1	0	0	0.35000
11		[Mat #]	6	8	8	8	8	8	8	8	8	0	0	0.24885
12	3	[angle]	7	0	90	0	90	90	0	90	0	0	0	0.35000
13		[# of ply]	8	1	1	1	1	1	1	1	1	0	0	0.70000
14		[Mat #]	9	8	8	8	8	8	8	8	8	0	0	0.32781
15	4	[angle]	10	0	90	0	90	90	0	90	0	0	0	0.70000
16		[# of ply]	11	1	1	1	1	1	1	1	1	0	0	1.05000
17		[Mat #]	12	8	8	8	8	8	8	8	8	0	0	0.37415
18	5	[angle]	13	0	90	0	90	90	0	90	0	0	0	1.40000
19		[# of ply]	14	1	1	1	1	1	1	1	1	0	0	0.40189
20		[Mat #]	15	8	8	8	8	8	8	8	8	0	0	

Exercise) Input material data for element group #2 with following parameters :

- Material number : 8 (T300/N5208)
- Layup : [0₃/45/-45/90]_S
- Angle between local axes and reference axes : 30°

3) Step 3.5 : Input node and element data with following parameters :

- Length of beam : 10
- Number of elements : 10
- First 5 elements : group #1
- Last 5 elements : group #2

The screenshot shows the NREL software interface with two tables:

NODE.XLS				
	A	B	C	D
1	node\	x	y	z
2	1	0.000	0.000	0.000
3	2	1.000	0.000	0.000
4	3	3.000	0.000	0.000
5	4	4.500	0.000	0.000
6	5	5.200	0.000	0.000
7	6	6.000	0.000	0.000
8	7	7.000	0.000	0.000
9	8	7.500	0.000	0.000
10	9	8.000	0.000	0.000
11	10	9.000	0.000	0.000
12	11	10.000	0.000	0.000

ELEM.XLS				
	A	B	C	D
1	elmt. #	group #	node 1	node 2
2	1		1	2
3	2		1	3
4	3		1	4
5	4		1	5
6	5		1	6
7	6		2	7
8	7		2	8
9	8		2	9
10	9		2	10
11	10		2	11

3) Step 3.6 : Generate ADAMS interface data from element #5 to element #6.

The screenshot shows the NREL.XLS table with the following data:

NREL.XLS		
1		
2		
3		
4	A	B
5	NREL Beam	
6	Adams	
7	First element	5
8	Last element	6
9	Total number of bricks	20



